Centre for Practical Teacher Training Gelsenkirchen
Seminar for the Teaching Profession at Vocational Colleges

Co-funded by the European Union

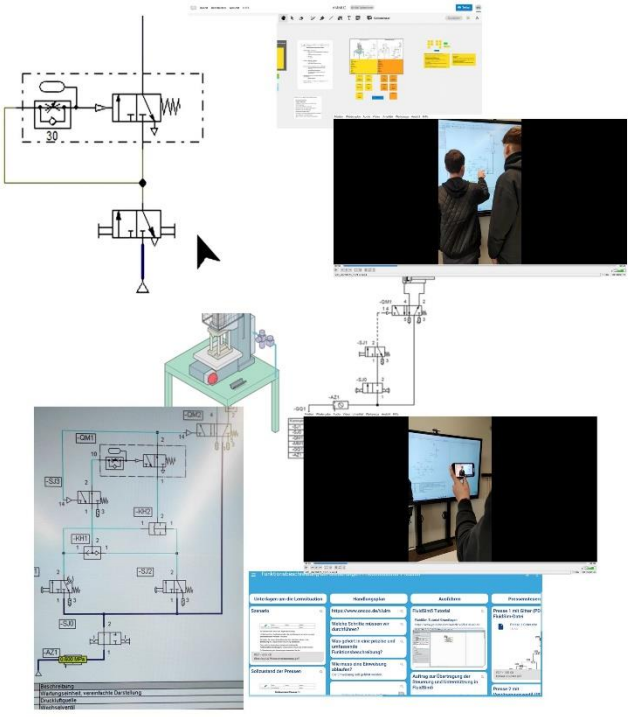
Sebastian Klinke

Lesson plan for the subject **mechanical engineering technology**

Class: Metalworkers / 1st year of training

Topic of the lesson:

Instruction of new trainees in the function of a pneumatic control to check previously created functional descriptions by creating video tutorials in learning tandems



1 Relevant planning principles

1.1 Individual students` skills

Through observations and discussions with trainees as well as written tests, person-related skills can be determined and support needs derived from them. In a separate file, the current performance levels of the trainees can be found in a **learning structure grid**, which was developed in the seminar.

	Student-related learning requirements	skills to be developed (long term)	Skills to be developed (actual lesson)
Ability to perform and learn	Heterogeneity due to the wide range of educational qualifications among the trainees (lower secondary school leaving certificate to A-levels),	Improving technical language comprehension	Promotion through the verbalisation of contents of the function description during the creation of a video tutorial
Willingness to perform and learn	The trainees seem rather sluggish and quickly distracted during theoretical input, and often over-motivated during practical exercises.	Creating a motivational fit for the learning group through alternating theory-practice settings	After an introduction, the trainees are given the opportunity to design a tutorial in a in a self-organised learning process within the guidelines of the developed functional descriptions of the pneumatic control.
Current technical knowledge	The trainees know the basic structure of pneumatic control systems from the last learning situation.	Increasing professional competence	
Current methodological knowledge	The trainees have some experience with Oncoo as a planning tool and Padlet and Conceptboard as an organisational tool.	Increasing methodological competence	
Learning atmosphere in the class	The trainees often treat each other disrespectfully.	Increasing social and human competence by forming teams with frequently changing learning partners	The learners work together in teams and have to make arrangements to create a good stdudy product (video tutorial).
Special features	Often high absences due to courses / work at the company	Repetition of content e.g. with Kahoot!	

1.2 Curricular and legal requirements for the lesson

The topic of the lesson *Instruction of new trainees in the function of a pneumatic control system for checking previously created function plans by creating video tutorials in learning tandems is derived from* the curricula for metal workers. The lesson is anchored in learning field 3 "*Production of assemblies",* the contents of which include the sub-contents "*Basics of control technology", "*Reading and creating *arrangement plans"* and "*Functional descriptions"* (cf. curriculum for metal workers 2002, p. 46). From the *didactic* annual planning of the Vocational College, which in turn is derived from the curriculum for the training for metal workers, it results that in learning field 3, within the framework of the subject of assembly units (TME), among other things, the competences for preparing *a functional description for the safe operation of the press*, the competences for *creating standardised circuit diagrams in FluidSim as* well as *for setting up and commissioning the newly developed control system* are taught (cf. Didactic Annual Planning 2022).

2 Medium-term teaching contexts

2.1 Basic didactic decisions and their justification

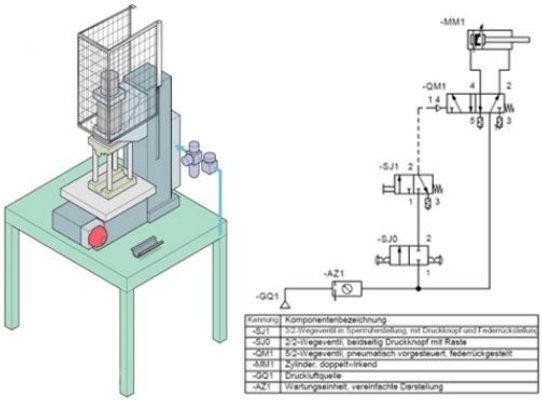
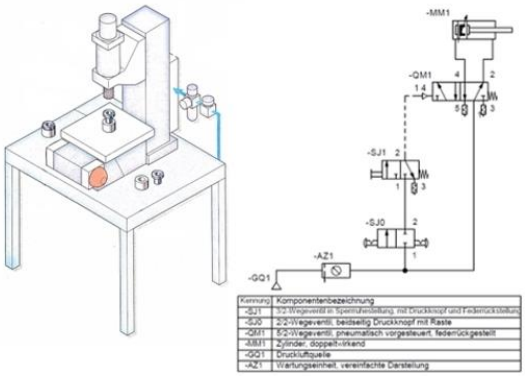
An important factor for didactic decisions in longer-term teaching contexts is individual support. This aspect is anchored in the German School Law (SG) § 1 and includes the support for trainees with learning difficulties as well as the support of more capable trainees. Students with deficits should receive help tailored to their needs and their learning process (cf. SG §2 (9)) and more capable students should be challenged and supported through supplementary offers (cf. SG §2 (11)).

For the lessons within the learning situation on retrofitting press controls, the focus will be on teaching **digital skills** in addition to **teaching technical skills** including the **comprehension and use of technical language**. According to our understanding of deeper learning, linguisation and especially the correct use of technical language play a central role in the learning process as cognitive discourse functions (cf. Coyle and Meyer, 2021). By creating the video tutorial, this effect can be significantly increased

compared to ordinary discussions of the results or short presentations. The awareness of the language is significantly increased through the medium of video.

No other support focuses are planned within the framework of the learning situation, as the measures to be developed could otherwise quickly take on a very complex dimension and consequently be very difficult for the supervising teacher to keep track of (cf. Individual support in heterogeneous learning groups 2011, p. 17). In order to be able to provide teaching materials for the trainees in the class that are adapted to their support needs and performance levels, the performance levels of the trainees are assigned to certain operators in a learning structure grid. The learning structure grid was developed within the framework of the seminar work in accordance with Wember, Kutzer and Polias and is stored in Annex K 7.5. One measure for individual support in the learning situation is the use of **two differently complex press controls**.

The Task
• Your master craftsman gives you the following order: As part of your training, you are to retrofit the control system on one of two existing presses. You are to instruct the new trainees in the coming year in the operation of the retrofitted control system. For this purpose, you are to prepare a precise and comprehensive functional description of the retrofitted control system. You will use the simulation software Fluis Sim to work on the controls. The functional description is to be presented to the department using the Fluid Sim programme. • Link to TaskCards: …

Problem Definition 1	**Problem Definition 2**
	
Conversion press 1 Specifications for conversion: The present press is to be equipped with a roller switch which detects whether the protective grille is lowered. The ram of the press should only be able to be extended when the protective grille is lowered. The ram shall be operated by means of a manual start button or a foot switch.	**Conversion press 2** Specifications for conversion: The present press is to be equipped with a two-hand safety circuit. With this circuit, both hands of the operating person must be outside the danger zone and operate two spatially separated switches within a certain time.

Further measures for **individual support**, which are used in the learning situation, is the use of support material such as optionally given **sentence starters and guiding questions** for the preparation of the functional descriptions of the press controls. The questions and sentence starters are intended to support trainees to deal specifically with the use of technical language and represent a graduated offer of learning support (Leisen 2020, p. 40, p. 56).

The design of the learning situation is work- and process oriented. In general, work- and process oriented teaching should have a high level of practical relevance to the trainees' real life or work, in which a task is oriented to operational processes in companies. This means that goals and contents should be developed along a probable work process as in the handling of an activity typical for the occupation to be taken up (cf. Riedl & Schelten 2006, p. 19).

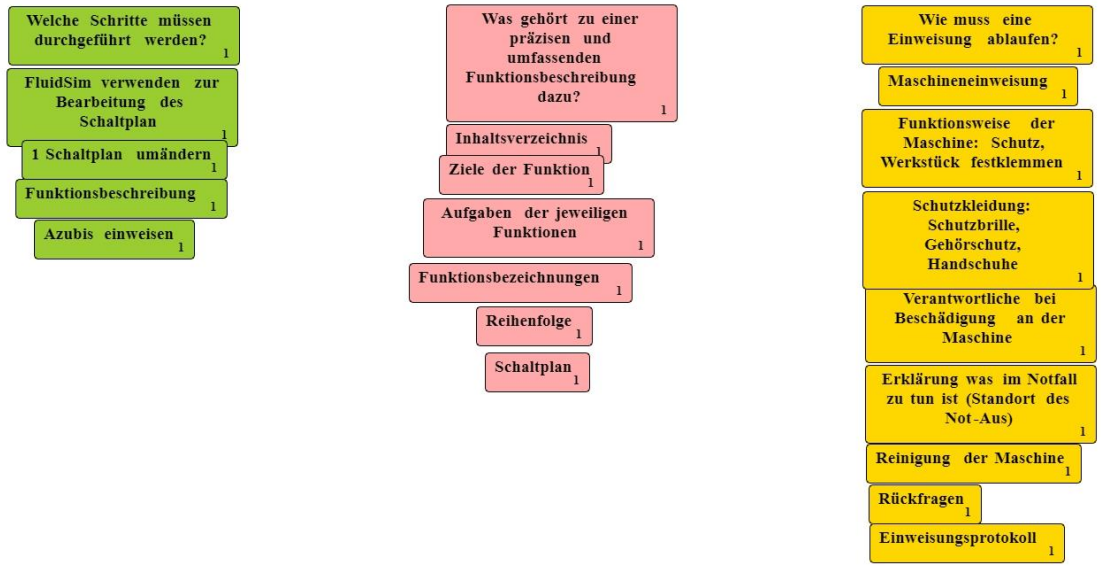
Support to describe the function	
Starters for sentences	**Guiding Questions**
1. The control system consists of ... 2. The control unit is operated by ... 3. The compressed air is directed as follows ... 4. When operated correctly, the ... 5. After the working process, the cylinder retracts again when ...	1. Which components are used in the control system? 2. Are there certain procedures in the operation of the control system that are particularly important and need to be mentioned? 3. How does the compressed air travel through the system? 4. What happens if the operation process is interrupted? 5. How do you structure your functional description? 6 Are there certain technical terms or abbreviations that should be used in the description of the function?

To make learning processes visible, working in learning situations in connection with the model of complete work processes is a suitable approach, since working in learning situations enables the creation of competence-oriented study products by trainees. The model of a complete work process consists of a sequence of six steps, that are passed through one after the other; however, not each step is obligatory. When the model is run through, a cycle is created from whose targeted reflection conclusions can be drawn for future learning situations as well as work and learning processes in the classroom (cf. Didactic Principles of Training 2023).

The trainees should be involved in the planning of their learning process. They should be led step by step to ever greater independence and the resulting personal responsibility for the learning products and the control of their learning processes. The aim is to increase the trainees' competence (cf. Meyer 1993, p. 211). For this reason, the trainees created an action plan at the beginning of the learning situation under the

guidance of impulses from the teacher. The process of creating action plans is still difficult for the trainees at this point in the training, as they have not yet dealt intensively with the process of work planning. The creation of action plans within learning situations takes place digitally in this class with the tool Oncoo. This tool enables a cooperative and flexible design of a joint action plan.

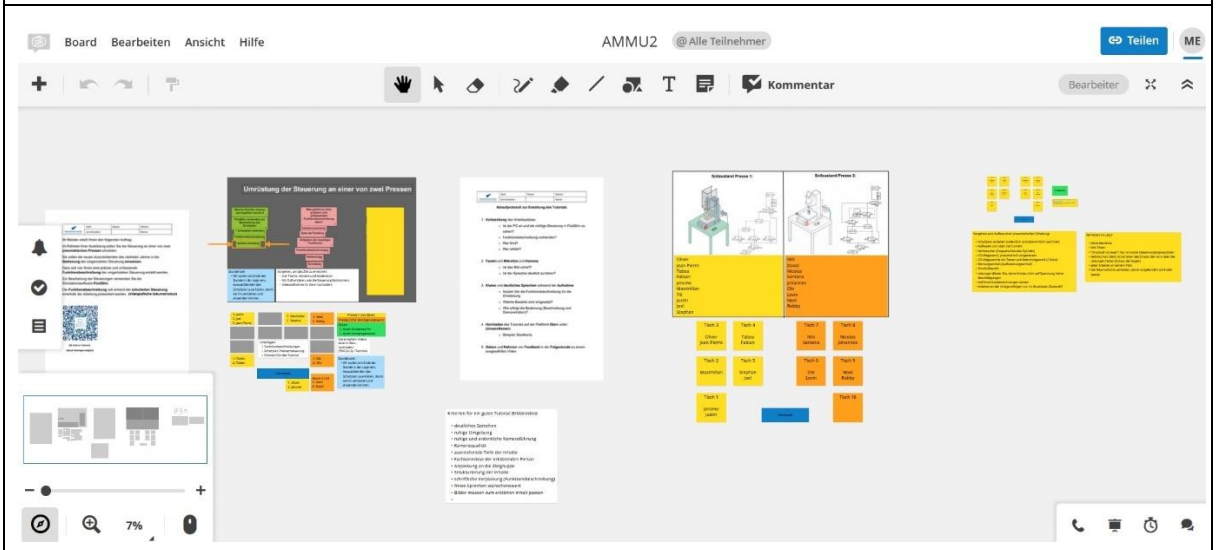
Work plan for the redesign of a press with pneumatic control mit Oncoo (www.oncoo.de)

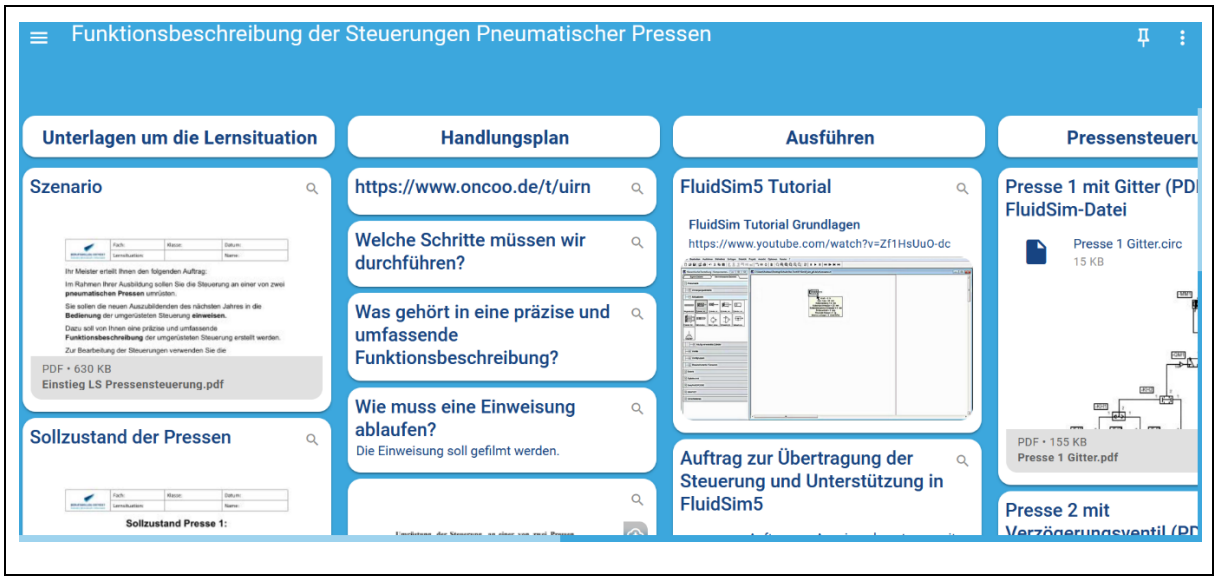


Digital tools are also used for working together and collecting information in order to integrate students' own smartphones into the lessons in a meaningful way so that they can meet the increasing challenges posed by the process of digitalisation. The acquisition of so-called 21st Century Skills should make it possible for trainees to master these challenges. The classification of the key competences was already done in 2003 within the DeSeCo project. The three key competences for acquiring 21st Century Skills are (1) *interacting in heterogeneous groups*, (2) *autonomous ability to act and* (3) *interactive use of media and resources*. The 21st Century Skills represent a general framework concept for the design of global education (cf. Roth et al. 2022, p. 6f). A supplement to the three competences of the DeSeCo project is the 4K model. It includes the competencies of collaboration, communication, creativity and critical

thinking (cf. ibid., p. 7), whereby neither the 21st Century Skills nor the competencies of the 4K model can be clearly distinguished from one another (cf. ibid., p. 30).

Making processes visible is one benefit of digitalisation in schools. By using digital tools such as learning management systems and student portfolios, students and teachers can better track and document students` progress. This can help to make learning processes more transparent and give students and teachers a better basis for collaboration and exchange. (cf. European Framework 2013, p. 36). Against this background, a suitable learning platform is an important tool to make work processes visible and to facilitate the self-organisation of student work. In this lesson, concept board is used for this purpose.

Conceptboard and Task Cards as working and organisational platforms (www.conceptboard.com / https://taskcards.eu)




The use of digital media and the acquisition of competences in the use of digital media can not only help to promote the exchange of trainees with each other, but also that students work together on a project, even if they are not physically in the same place or are in different groups. This can facilitate the exchange of ideas and collaboration and help students benefit from the different skills and perspectives of their classmates (cf. Schaumburg 2015, p. 35).

In order to be able to check domain-specific competences that are taught in the context of a learning situation or a lesson, observable behaviour must be present (cf. ibid. p. 6). For this reason, the trainees are repeatedly encouraged to demonstrate their competences in the course of the situation. This happens, among other things, within the framework of the assessment of the trainees' work processes and within the framework of presentation phases, in which particular emphasis is placed on the linguistic expression of learning content, including the use of technical language.

Vygotsky describes the learning process as a three-stage process: from the material phase to the linguistic phase to the mental phase of processing content. Only when content can be linguised can a deeper mental processing of learning content take place. Verbalisation represents a (competence-oriented) intermediate step that should be verifiable by teachers (cf. Lantolf et al. 2015, p. 20). For this reason, within the framework of the learning situation, the trainees are repeatedly encouraged through

learning settings such as learning tandems, presentation phases, think-pair and share phases (think-pair-share method) to deal with the linguisation of (subject) content in the classroom, also using supporting material.

At the beginning of the situation, the teacher determined the teams with the help of the learning structure grid in the appendix (K 7.7) so that the trainees would not work together according to sympathy but according to their performance. The learning structure grid was developed according to Wember, Kutzer and Polias within the framework of the seminar work. The performance levels of the trainees were determined through their own observations in class and written performance records. The grid can provide a good orientation to the performance level. After each learning situation or performance record, or after larger assessable teaching contexts, the individual development of the trainees is re-evaluated in relation to the learning structure grid. The further to the right a box is in the matrix, the more facts or later also processes and contexts trainees can grasp and process. The higher a box is placed, the better the cognitive processing depth or the ability to deal with the information gained (*remembering* via *analysing up* to the highest level of *creating/problem solving*).

In the last learning situation, the trainees have already read and drawn their own circuit diagrams and then built the developed pneumatic control system using the developed circuit diagrams, including the naming, function and use of various components (3/2-way valves, 5/2-way valves, single and double-acting cylinders, maintenance unit, time elements and end position detection). In the context of the last learning situation, the trainees often worked out learning contents in group or partner work, partly group puzzles. The learning situation that follows on from this learning situation contains the practical assembly of pneumatic controls in connection with the action product of the assembly instruction.

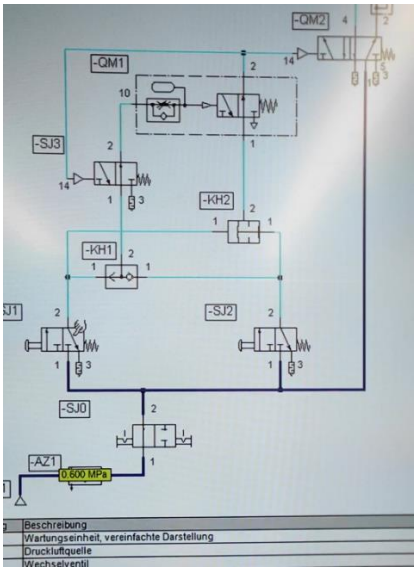
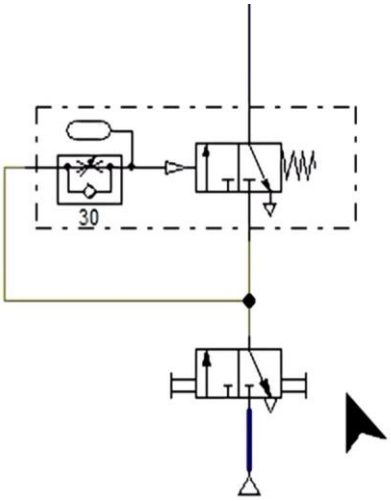
2.2 The learning situation at a glance

Lesson	Action Step	Topic of the lesson
Lesson 1+2	**Inform, Analyse Plan and Decide**	Analyse the order for retrofitting the press controls in order to be able to create an action plan for the further procedure in the learning situation, using the Think-Pair-Share (TPS) method. The learners cooperatively define the action product (functional description) and assessment criteria.
Lesson 3+4	**Perform**	Creation and simulation of the circuit diagrams of the press controls in FluidSim including creation of a parts list (I)
Lesson 5+6	**Perform**	Creation and simulation of the circuit diagrams of the press controls in FluidSim including creation of a list of the needed components (II)
Lesson 7+8	**Perform**	Creation of a functional description for the simulated press control with the help of the circuit diagrams created in FluidSim.
Lesson 9	**Control**	Instruction of new trainees in the function of a pneumatic control system for checking previously created function plans by creating video tutorials under formation of learning tandems
Lesson 10+11	**Rate** **and** **Reflect**	The trainees give each other feedback on their created tutorials and the functional descriptions. The trainees reflect on the contents, methods and competences they have learned or acquired in the course of the learning situation.

3 Example: Didactic idea in the context of lesson 9

The lesson is part of a learning situation in which the conversion of a pneumatic system in the trainees' own company is discussed. The lesson, which takes place in UE 6, focuses on the teaching of digital competences. The aim is to increase the trainees' competences in handling digital media and especially the simulation software FluidSim and to teach them how to create video tutorials. The trainees should be able to instruct other trainees in the operation of pneumatic controls with FluidSim and to create a video tutorial and upload it to iServ. **FluidSIM is a software for creating, simulating, teaching and learning electropneumatic, electrohydraulic, digital and electronic circuits.** FluidSIM also enables the interactive simulation of self-created circuits. The software thus represents an exemplary tool for interactive familiarisation with the design and verification of control engineering problems. The advantage is that learners can learn at their own pace and get direct feedback on the functionality of their circuits

via the simulation function. The software has a library where students can find out how unknown components work. Complex logical connections are additionally explained in learning videos. Thus, on the basis of joint work planning, a largely independent learning process by the students is possible.

Fluid Sim (www.festo.com)	**Additional explanatory video**
	time delayed pressure supply 

The competences to be increased or acquired within the framework of this lesson can be assigned to the digital key competences (cf. Promotion of digital key competences 2021, p. 8). Due to technical problems on the PCs in the lesson before the class visit, not all trainees were able to save their created functional description. For this reason, they receive a functional description created by fellow trainees so that they are ready to work in the lesson to be shown.

During the lesson, the trainees produce a video tutorial based on the pneumatic controls and functional descriptions they have created in FluidSim. The instruction is aimed at another (future) trainee who is to be instructed in the function and operation of the control with the help of the tutorial created by the trainees. In the following lesson, the videos are used by the learners for a peer review in order to practice giving and receiving feedback. The visualisation of the controls in FluidSim should make it easier

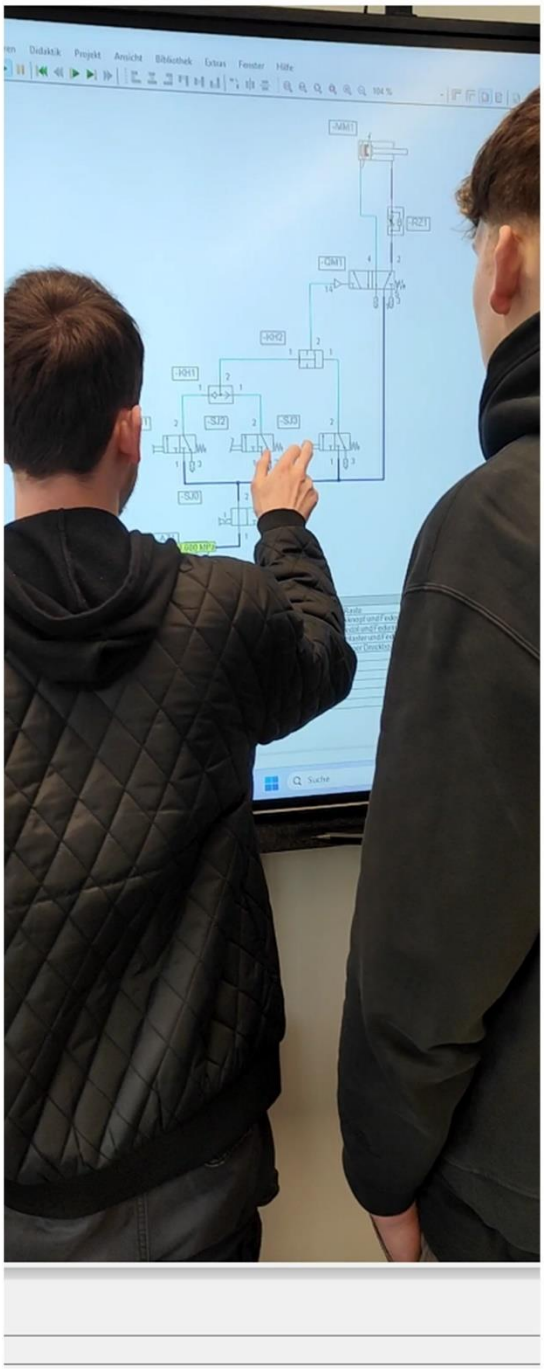
to understand the function. The practical construction of the control system takes place in a subsequent learning situation.

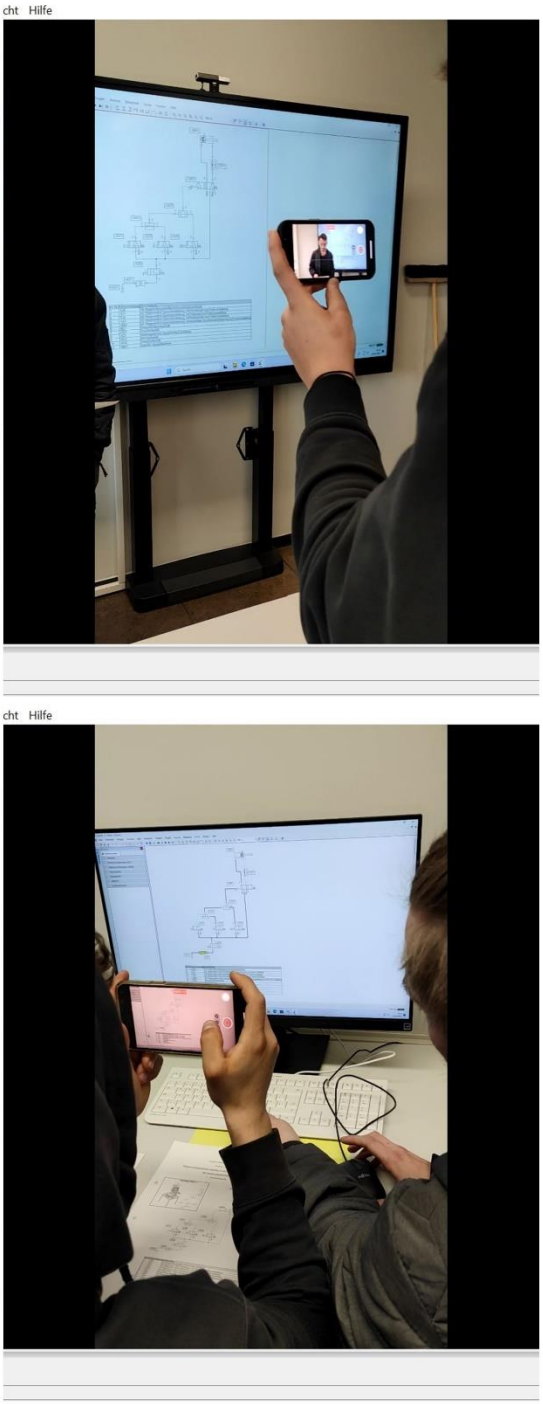
Through the targeted examination of the contents for the instruction on the basis of the functional description within the tutorials, a better depth of processing of the contents should be achieved with the trainees, which, as described by Vygotski (cf. Lantolf et al. 2015, p. 20), can only take place through a linguisation of the contents (material phase -> linguistic phase -> mental phase). Here, the linguisation represents a performant, verifiable, competence-oriented achievement.

The trainees expand their competences in the area of application know-how (AK) in dealing with FluidSim and in the area of media competence (MK) by creating and uploading the tutorial on iServ. When creating the tutorial, they analyse their own work processes and evaluate them in terms of information content, relevance and topicality (cf. Promotion of Digital Key Competences 2021, p. 8). Uploading the tutorial on iServ enables the trainees to develop their digital competences in the field of AK, as they use basic file formats and methods for data exchange and backup (cf. ibid., p. 8).

Flowchart for the creation of the tutorial
1. Preparation of the workplace: Is the PC switched on and the required control loaded in the Fluis Sim software? Function description available? Who is filming? Who is explaining? 2. Testing the microphone and camera: Is the image section well chosen / the image clear? Can the speaker be heard clearly? Speak clearly and distinctly during the recording! 3. Upload the tutorial to the IServ platform at: (name / group XXX) 4. Feedback will be given in the next lesson.

Creation of video tutorials





Photos Michael Erz / ZfsL

4 Objectives of the lessons

4.1 Central objectives

Level 1: The trainees are able **to name** the components of the control system by simulating the sequence of the function with explanations for another trainee in a video tutorial.

Level 2: The trainees are able **to explain** the function of the control by introducing another trainee to the operation of the control in a video tutorial.

4.2 Promoted competencies in the described lesson

The trainees... **Subject-related competences**	...are able to explain the functions of the components of the control system in detail and describe their interaction in the sequence of operation in order to expand their professional competences.
The trainees... **Methodological competences**	...expand their methodological competences by creating a video tutorial, selecting relevant information and contexts in a structured way, recording them on video and uploading the result to the iServ platform.
The trainees... **Social and human competences**	...expand their social and human competences by working cooperatively within a team and taking shared responsibility for the joint product (video tutorial).
The trainees… **Digital key competencies**	…expand their digital competencies ... by structuring their work process with the organisational tools, by using Fluid Sim with its help functions to create the video, by creating and editing a video recording with a mobile phone.

5 Lesson plan (lesson 9)

Learning Outcome:	**Video Tutorial**		
Topic of the lesson:	Instruction of new trainees in the function of a pneumatic control to check previously created functional descriptions by creating video tutorials in learning tandems		
Aim of the lesson:	**Level 1**: The trainees are able **to name** the components of the control system by simulating the sequence of the function with explanations for another trainee in a video tutorial. **Level 2**: The trainees are able **to explain** the function of the control by introducing another trainee to the operation of the control in a video tutorial.		
Steps	**Action steps / factual aspects**	**Social and action form**	**Media**
Inform **Plan and** **Decide**	With the help of the work planning in the concept board / task cards, the trainees describe the current work status and determine the next work steps. The trainees determine the objective of the lesson (possible student solution: At the end of the lesson we want to be able to instruct other trainees in our pneumatic controls). The learners form learning tandems. In each tandem, one of the two previously prepared descriptions of the function and the circuit diagram are available (for press 1 or for press 2).	Plenum	Smartboard, concept board Learning situation, action plan, circuit diagrams, functional descriptions
Perform & Save	With the help of the functional description, the learners create a video tutorial on the structure, function and operation of the press control and upload the result to the iServ platform.	Learning tandems	Smartboard, table book, smartphone, FluidSim, created controls, flowchart, iServ
Rate	The learners reflect on whether the instruction in the operation of the control system was successful and how the contents covered relate to their everyday work.	Plenum	Smartboard, action plan Concept board

optional	The learners swap roles within the tandems (filming trainee⇔ moderating trainee) and create another tutorial with swapped roles and upload it.	Plenum	Smartboard, FluidSim

6 Literature

Berufskolleg Ostvest (2022). Didactic annual planning for Annex A of the training occupation metalworker.
<https://dwo.bk-ostvest.de/index.php/lernsituation_controller/lernsituation_zeigen/59/3/2/480/2596/0/4893> [06.04.2023].

Bildungspläne Fachklassen des dualen Systems (2002). Lehrplan zur Erprobung Metallbauerin/Metallbauer
<https://www.berufsbildung.nrw.de/cms/upload/_lehrplaene/a/metallbau.pdf> [06.04.2023].

Brüning, L., Saum, T. (2009). Teaching successfully through cooperative learning - strategies for student activation. Essen. Neue Deutsche Schule Verlagsgesellschaft mbH

Didactic principles of education (2023). <https://www.bibb.de/de/141447.php> [06.04.2023].

European Framework, (2013). DIGCOMP: A Framework for Developing and Understanding Digital Competence in Europe.
<https://publications.jrc.ec.europa.eu/repository/bitstream/JRC83167/lb-na-26035-enn.pdf> [07.04.2023.]

Promotion of digital key competences (2021). Handreichung zur Integration digitaler Schlüsselkompetenzen in die Berufliche Bildung. Ministry for Schools and Education of the State of North Rhine-Westphalia. Düsseldorf

Individual support in heterogeneous learning groups (2011) Handout on basic principles and possibilities of implementation at vocational colleges. Volume 1.
<https://www.berufsbildung.nrw.de/cms/upload/individuelle_foederung/handreichung_individuelle_foerder1.pdf> [21 MAR. 2023].

Lantolf**, J., Thorne, S. L., & Poehner, M. (2015)**. Sociocultural Theory and Second Language Development. In B. van Patten & J. Williams (Eds.), Theories in Second Language Acquisition (pp. 207-226). New York: Routledge.
<https://www.researchgate.net/publication/313795407_Lantolf_J_Thorne_S_L_Poehner_M_2015_Sociocultural_Theory_and_Second_Language_Development_In_B_van_Patten_J_Williams_Eds_Theories_in_Second_Language_Acquisition_pp_207-226_New_York_Routledge> [22.03.2023].

Leisen, J., (2020). Handbuch Sprachförderung im Fach - Sprachsensibler Fachunterricht in der Praxis. Ernst Klett Sprachen GmbH. Stuttgart.

Meyer, H., (1993). Guide to lesson preparation. 12th edition. Cornelsen Scriptor GmbH & Co. Berlin.

Meyer, O., Coyle, D. (2022). Beyond CLIL – Pluriliteracies Teaching for Deeper Learning. Cambridge University Press.

Riedl, A., Schelten, A. (2006). Handlungsorientiertes Lernen - Aktuelle Entwicklung aus der Lehr-Lern-Forschung und deren Anwendung im Unterricht. TU Munich.

Roth, J., Baum, M., Eilerts, K., Hornung, K., Trefzger, T. (2022). The future of STEM learning - Volume 1. Perspectives on (digital) STEM teaching and teacher education. Springer Spektrum Berlin, Heidelberg.

School Act §1. Right to education, upbringing and individual promotion. <https://bass.schul-welt.de/6043.htm#1-1p1> [03.12.2022]

School Act §2. Education and educational mission of the school. <https://bass.schul-welt.de/6043.htm#1-1p1> [03.04.2023]

Schaumburg, H., (2015). Chancen und Risiken digitaler Medien in der Schule - Medienpädagogische und -didaktische Perspektiven. Bertelsmann Foundation <https://www.bertelsmann-stiftung.de/fileadmin/files/BSt/Publikationen/GrauePublikationen/Studie_IB_Chancen_Risiken_digitale_Medien_2015.pdf > [25.03.2023]

Metal Table Book (2014). Haan-Gruiten: Verlag Europa-Lehrmittel Nourney, Vollmer.

Co-funded by the European Union

Funded by the European Union. Views and opinions expressed are however those of the author(s) only and do not necessarily reflect those of the European Union or the European Education and Culture Executive Agency (EACEA). Neither the European Union nor EACEA can be held responsible for them.

Licensed under a Creative Commons 4.0 Attribution International License